Price cannibalisation and future solar PV deployment

Economics | The growing volumes of variable solar and wind generation on the grid raise the risk of depressed wholesale prices, particularly at times of high generation and low demand. James Brabben of Cornwall Insight explores the phenomenon of so-called price cannibalisation and how its most serious potential impacts on the renewables industry can be avoided

Credit: Vattenfall

As we move towards the Net Zero 2050 target set by government, a key question for investors, developers and policy makers alike is what business models can be utilised to incentivise the rapid expansion of new renewables assets.

Looking at the Climate Change Committee's (CCC) Net Zero report (Net Zero – The UK's contribution to stopping global warming 2019) assessing the UK's long-term emissions targets, it is estimated that between 9GW and 12GW of new-build capacity per annum is needed on top of the current ~110GW market to generate approximately 600TWh of electricity a year by 2050, doubling the levels of today's market (~300TWh).

The opportunity is apparent, investment is being signposted towards low carbon renewable generation assets, with the majority focused on the mature and economically viable wind and solar PV technologies.

We at Cornwall Insight build our own long-term market models, looking at power price assessments, technology deployment and the carbon intensity of the grid out to 2050 to meet these targets. In our latest range of scenarios, we forecast that between 10GW and 28GW of solar PV could be built between now and 2050 to meet Net Zero. Supported by further falls in levelised costs of energy (LCOE), the trajectory of solar PV development may seem clear.

However, one key aspect we factor into our assessments for long-term power prices is a view on the "captured price" of solar PV and the degree to which price cannibalisation impacts PV and other renewable technology revenues. Currently, this is having a profound impact on how developers and investors configure their views on project revenues and expected returns, causing doubts among many in the community.

The growing volumes of solar and wind on the grid bring greater price risks

What is price cannibalisation?

So, what is price cannibalisation? Price cannibalisation describes the depressive effect on wholesale prices where large volumes of 'must-run' power plant continue to operate during periods of oversupply from generation and/or low demand. The effect is most marked during periods where there is a predom-

inance of output from subsidised, intermittent renewable generation, such as solar PV or wind.

As these technologies have no fuel costs and low operating costs, they have comparatively low short run marginal costs (SRMC) and can out-compete fuelled plant. This results in high-cost, inefficient thermal plant being squeezed to the margins, with cheaper more efficient thermal plant setting the price, or possibly all thermal plant being pushed out of merit. The results can be dramatic, causing very low or even negative prices at times of high intermittent renewable generation.

The renewable subsidy schemes operating in the GB market – for solar PV, namely the Renewables Obligation (RO) and the feed-in tariff (FiT) scheme – provide generators with revenue based on volume of electricity produced, providing a simple prerogative to maximise output. No subsidy is paid when the generator is not producing, hence there is an opportunity cost for not generating.

The incentive is therefore to continue to produce when the market is otherwise oversupplied and the wholesale price falls. The incentive is even to continue to do so if prices turn negative, up until the point this negative value reaches subsidy revenue. The strength of this incentive, and the wholesale price ranges in which it applies, depends on the value of the subsidy received and the scheme under which it is paid.

Typically for solar PV, this will either be a 1.2ROC/MWh, 1.4ROC/MWh or 1.6ROC/MWh of RO subsidy or the more lucrative FiT scheme for sub 5MW projects. Of the total ~13GW of solar PV capacity in GB, 6GW is accredited under the RO scheme while a further 5GW is under the FiT scheme. A small proportion of capacity is under the contracts for difference (CfD) scheme at 40MW, while the remainder of capacity is subsidy free.

The signal to generate even in times of low or negative prices can be robust for this existing solar PV fleet. For a solar plant receiving 1.6ROCs/MWh, RO subsidy is currently worth over £85/MWh, while under the FiT scheme early ground-mounted projects built before 2012 can receive generation tariffs well in excess of £300/MWh. Under the CfD scheme, negative price provisions are in place to limit the incentives, but these only kick in for existing projects after six consecutive hours of negative day-ahead hourly prices, an event yet to happen in the GB market.

What is the impact now?

With incentives in place to continue running even at times of surplus electricity, as renewables capacity has grown in the last decade, especially for solar PV and wind, the degree of price cannibalisation has increased. What has surprised many in the market is the degree to which it is already a key feature impacting project returns.

We have been tracking the impact of pricing cannibalisation in our market research since 2015 and have noted an increasing disparity between the baseload electricity price and captured value of wind and solar PV.

Figure 1 details these trends, with a key aspect being the more pronounced decrease in solar PV capture prices over the period from a positive annual average in 2015, meaning a value captured typically above baseload power prices, to averaging around 2% below the captured price by the end of last year.

The reason, as noted above, is simply due to high solar PV deployment across 2015, 2016 and 2017 following a rush to build new sites to beat RO and FiT scheme closure and banding change dates.

The cannibalisation effect for solar projects is less profound than for wind currently, but still significant. Solar power benefits from delivering most of its output during the peak periods (Monday-Friday, 07:00 to 19:00) when demand is high, and therefore tracks closer to

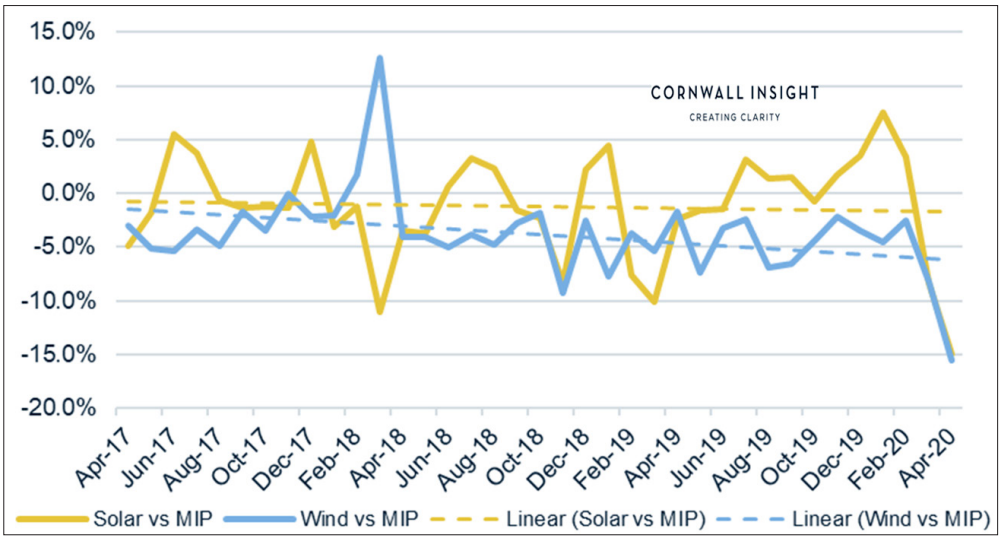

Figure 1. Historical captured prices for solar and wind versus the market index price (MIP)

baseload power prices as a result of a less dramatic merit order impact than wind. The cannibalisation effect for solar and the propensity for zero or negative pricing is greatest at weekends (and bank holidays), and from May to October, when demand is lower and solar output is at its highest.

Everyday operational impacts

We at Cornwall Insight are not alone in factoring this into our assessment of value. Through our Power Purchase Agreement (PPA) market research it is clear that suppliers and off-takers trading the power from solar PV assets are factoring current price cannibalisation into their PPA price offerings in the form of higher discounts against baseload prices. Many solar PV generators already take the decision to fix prices in their PPAs for 12-36 months in order to mitigate the impacts of this discount and the price cannibalisation.

There is also an appreciation of cannibalisation in government, with the Department for Business, Energy and Industrial Strategy (BEIS) incorporating a different and lower "intermittent wholesale power value" compared to the baseload view in its assessment of future wholesale prices in the last round CfD Allocation Round.

For generators in the market who are not fixing prices in their PPAs, the impact of COVID-19 has also laid bare how differences in selling strategy can have a material impact on asset returns. Those who may have fixed value in late 2019 or early 2020 are now reaping the benefits of the protection afforded to them, whilst those on market-linked contracts are subject to periods of extremely low wholesale prices.

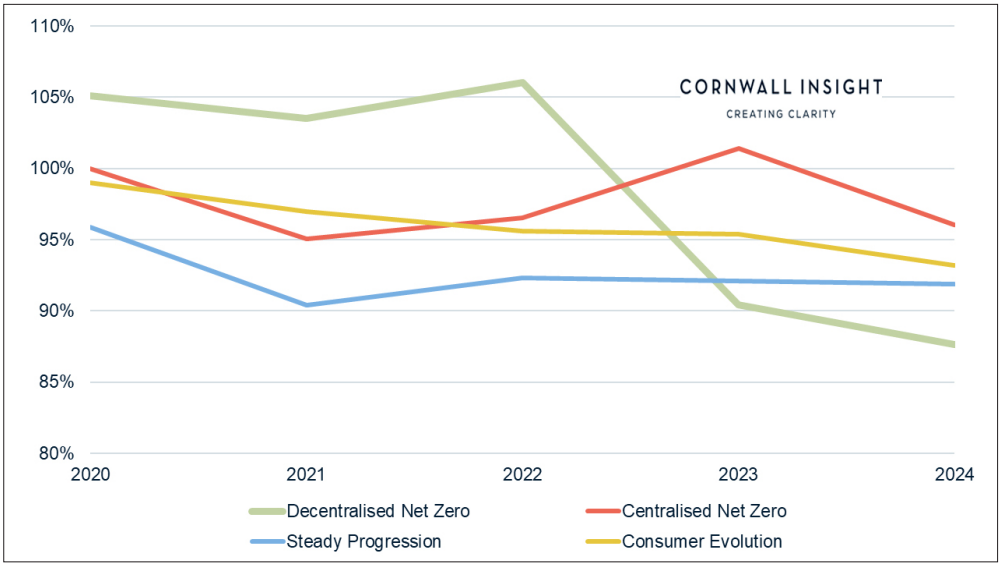

Figure 2. Solar PV captures rates under different Cornwall Insight scenarios – 2020-2024

The cannibalisation effect has dramatically increased since lockdown measures were introduced in March and for the first time in GB, we have seen consecutive periods of negative day-ahead hourly price periods. This correlated almost exactly with high solar PV output periods across the middle of the day. For those on market-linked contracts with exposure to market prices, COVID-19 impacts have had a material impact on returns.

What the recent trends with COVID-19 have shown is the degree to which high renewables penetration from wind and solar PV can impact on wholesale price formation. With renewables penetration rising suddenly with the ~20% fall in demand driven by lockdown measures, the current market provides a glimpse into the potential future when renewables consistently account for 50% or more of generation.

The coming years for price capture

Back in 2018 we undertook our first long-term assessment of price cannibalisation out to 2030 to understand what this future may look like. At the time, we calculated that price cannibalisation could see solar price capture fall below 95% by 2030, with wind capture below 80%. This was based on a view of market developments at the time, well before more stretching legislation was passed on Net Zero emissions targets, pledges for 40GW of offshore generation were launched and further falls in LCOE were taken account of.

Since this time, we have updated our assessments to incorporate these views and our latest assessment in March 2020 provides a starker picture. The need for higher build out of zero marginal cost solar PV and wind to meet Net Zero targets is likely over time to reduce wholesale power prices and expected capture rates. A higher proportion of generation from variable sources will also increase price volatility. Compared to our 2018 assessment our latest analysis shows that solar PV capture rates could drop on an annual basis below 90% by 2025. Taking a more granular look, monthly capture rates could range from over 100% to below 87%. As expected, solar PV may see less of an impact than wind, where the acceleration of offshore wind growth has knock-on impacts for the onshore fleet.

Should they develop, unsubsidised solar PV projects would need to turn off once prices drop below their operating costs and may have to do so more often than previously expected and when compared to their peers under RO, FiT and CfD schemes.

The impact on future developments could therefore be profound and propose material questions for industry and policy makers alike about the ambitions to deliver the maximum capacity of low carbon generation at the lowest possible cost:

- In a low or low capture wholesale price environment will intermittent renewables be financially viable without subsidy?
- If subsidies or substituting revenues are not available how will these projects be financed? The established project finance model relies on a combination of fixed or floor prices and subsidy to ensure debt can be covered. A volatile market with falling capture rates will likely reduce the level of floor prices. Investing against lower floor prices or increasing reliance on wholesale power revenues would see costs of capital increase
- What will be the effects on the wholesale market and trading behaviours of participants? Our analysis shows a wholesale market with increasing price volatility as the sources of dominant supply switch between 'must-run' subsidised generation and flexible, short-run marginal price-based generation. This creates a high-risk environment with significant implications not just for generators, but for all parties including off-takers, suppliers and end-users and the system operator
- What does the projected level of volatility mean for the point at which different sources of flexibility, particularly battery storage, become economically viable? And in the case of battery storage at what stage can it viably play a role in mitigating cannibalisation effects for intermittent renewable generators, especially solar PV?

Solutions and market response

Fortunately, a number of new business models aiming to provide solutions to these questions have matured over the last two years.

To de-risk against volatile wholesale revenues, many generators have turned towards corporate PPAs (CPPAs), either for grid-connected assets or in direct private wire arrangements. When agreed at the correct price level, these models can provide long-term fixed-price arrangements, which suit the debt-raising project finance model that assets are used to. CPPAs have been signed recently by NextEnergy and Lightsource BP with credit-worthy counterparties such as Anglian Water and ABinBEV for their GB operations. We note through our research that many more CPPAs are in the pipeline.

However, the "queue" of generators is far longer than that of corporates, with our forecasts showing the onshore wind and solar PV pipeline measured in potential GWh is at a 3:1 ratio against credit-worthy corporate volumes that may require a CPPA. Recent and dramatic falls in wholesale prices, driven by the COVID-19 lockdown, have also tempered corporate appetite for a deal where prices are typically over £40/

MWh. Added to this, private wire and behind-the-meter models are having to reconfigure their assessments of revenues in light of large-scale changes to network charging under Ofgem's two Significant Code Reviews, the Targeted Charging Review (TCR) and the Network Access and Forward Looking Charges Review (NAFLC).

As a result, developers have also turned to large off-takers to try and negotiate purely merchant "utility PPAs". With the long-term off-take market in GB as competitive as it has ever been in our latest PPA market research, many developers are seeking to structure long-term floor and fixed-price arrangements to try and de-risk financing of new projects. However, as already noted off-takers are acutely aware of the price cannibalisation risk and heavy discounts or low floor prices are still the norm.

Some developers are going further, trying to make projects more attractive to off-takers and the wider market by reducing cannibalisation risks through co-location. Incorporating volatility into the revenue stack can support projects; perhaps the most striking example is the proposed Cleve Hill Solar Park in Kent, a mammoth 350MW solar park with large-scale battery capacity attached. The aim of this and similar models is to mitigate the risk of cannibalisation through storing excess power in batteries to be exported at times of higher or peak pricing. Added to this are additional revenue opportunities in markets such as the Capacity Market, Balancing Mechanism and Balancing Services contracts.

Hybrid or "power-park" sites for solar PV are also being proposed, typically looking at solar, battery and gas peaking configurations. These again look to access upside in market volatility, and also optimise grid connections to ensure the site's network capacity can be fully utilised. Other developers are using more techno-economic solutions to the problem, such as tracking or bifacial panel technology, which can increase yields and smooth the shape of asset production.

For these examples however, we note that "stacking" all of these revenues together into a bankable model can be difficult with balancing revenues typically very short-term in nature and markets for batteries such as frequency response currently heavily oversubscribed. Technical solutions also have to ensure that cannibalisation protection and greater production rates outweigh additional panel costs.

Finally, and only an option put back on the table recently by BEIS, is the possible re-integration of solar PV and other 'Pot 1' technologies including onshore wind and energy from waste into Allocation Round 4 (AR4) of the CfD scheme. Whilst budget parameters and strike price caps are still yet to be confirmed by BEIS, as is the confidence that procurement will go beyond the AR4 auction proposed for 2021, the opportunity for subsidy-based support may be back on the table for solar PV.

The benefits of the scheme in protecting against price cannibalisation are clear with the 15-year inflation-linked contract and guaranteed price obviously likely to prove attractive to the pipeline of solar PV projects. We note from our pipeline research of planning data that over 1.8GW of solar PV could be eligible and able to bid for a 2021 auction.

A question for bidders would be the strike prices achieved in the auction, with the history of the CfD scheme showing just how low prices can go. Low prices may even deter solar PV bidders, especially against competition from onshore wind, and attention could turn instead towards how other routes to market could offer protection against cannibalisation.

Silver linings

If any solar PV is successful in the next CfD round, the result would highlight the degree of difference in price cannibalisation exposure between the "haves" of those with a CfD and the "have nots" of those without.

Unless government budgets are loosened then there will be a large swathe of renewables development that does not access the CfD. These assets will have to protect against the impact of cannibalisation knowing full well that further deployment of all technologies through the CfD would add to the cannibalisation issue and make the impacts more pronounced for those exposed to the market.

But there could well be a silver lining in the form of electrification of transport and heat in the coming decade. Whilst our modelling shows a downward trend in capture rates out to 2025, under more aggressive scenarios that meet Net Zero an uptick in demand is expected from the middle of the decade as the penetration of electric vehicles (EVs) rises and the electrification of heating grows. The additional volumes and potential flexibility these sources of demand offer could provide an uplift to solar PV assets as technologies such as smart charging and vehicle-to-grid (V2G) charging shift large elements of EV demand from periods of high price to lower price periods. The delivery of Net Zero targets through transport and heat should have positive implications in raising demand, and thus the need for new generation, and in providing greater flexibility on the demand side than currently seen.

The question for solar PV developers building subsidy free will be: when will this trend emerge and how certain can we be that it will create the opportunities, or help mitigate the cannibalisation risks, to support projects. Investment certainty cannot be guaranteed, and relying on smart charging or heating solutions to support renewables generation is certainly a less secure business model than traditional subsidy models.

As the volume of assets, notably offshore wind, under the CfD scheme increases through this decade, we believe wider questions will emerge as to whether the current wholesale market design is fit to support new-build subsidy-free renewables such as solar PV. ■

Author

James Brabben leads Cornwall Insight's wholesale team, which provides research subscription services across renewables, flexibility and commodities markets. He is also active in consulting and research areas covering his specialist knowledge areas of PPAs, renewables policy and green certificates, and regularly speaks on these at industry events. Cornwall Insight provides research, analysis, consulting and training to businesses and stakeholders in the Great British, Irish and Australian energy markets, leveraging a combination of analytical capability, a detailed appreciation of regulation codes and policy frameworks, and a practical understanding of how markets function.

Turn to p.71 for a banker's view on the future of unsubsidised solar post-COVID-19